

## CLAIMS

What is claimed is:

1. A liquid crystal display, comprising:
  - a first substrate having an optically transmissive character;
  - a second substrate positioned adjacent to the first substrate and having a reflective character and an active area bordered by a perimeter seal area;
  - a plurality of spacers configured about the perimeter seal area of the second substrate, wherein the first substrate is separated from the second substrate by the plurality of spacers so as to form a cell gap; and
  - a liquid crystal material positioned in the cell gap between the first substrate and the second substrate.
2. The liquid crystal display of claim 1 further comprising:
  - means for communicating directly between the first substrate and the second substrate.
3. The liquid crystal display of claim 2 wherein the means for communicating is at least one cross-over.
4. The liquid crystal display of claim 3 further comprising:

3 a first alignment layer disposed on a bottom surface of the  
4 first substrate; and

5 a second alignment layer disposed on a top surface of the  
6 second substrate, wherein the top surface of the second  
7 substrate is complementary to the bottom surface of the first  
8 substrate and

9 wherein the at least one cross-over is pierced through the  
10 first alignment layer and the second alignment layer.

1 5. The liquid crystal display of claim 4 wherein the at  
2 least one cross-over contains nickel particles and first  
3 alignment layer and the second alignment layer contain  
4 polyimide.

1 6. The liquid crystal display of claim 1 further  
2 comprising

3 a conductive coating disposed without patterning on a  
4 bottom surface of the first substrate.

1 7. The liquid crystal display of claim 6 wherein the  
2 conductive coating is made of a transparent metal oxide.

1 8. The liquid crystal display of claim 7 wherein the  
2 transparent metal oxide is Indium Tin Oxide.

1 9. The liquid crystal display of claim 1, wherein the  
2 plurality of spacers are limited to the perimeter seal area.

1        10. The liquid crystal display of claim 9, wherein each of  
2 the plurality of spacers is a sphere having a diameter of  
3 approximately 2.1 microns.

1        11. The liquid crystal display of claim 10, further  
2 comprising a sealing material configured about a portion of the  
3 perimeter seal area, wherein the plurality of spacers are coated  
4 with the sealing material.

1        12. The liquid crystal display of claim 1, wherein the  
2 second substrate is a single crystal semiconductor substrate,  
3 the active area includes a circuit panel, the cell gap measures  
4 approximately 1.5-3.0 microns, and one end of the first  
5 substrate extends over a complementary end of the second  
6 substrate so as to expose an offset portion on a surface of the  
7 second substrate.

1        13. The liquid crystal display of claim 12 further  
2 comprising:  
3 means for transmitting audible signals; and  
4 means for converting sound waves into an electric current.

1        14. The liquid crystal display of claim 13, wherein the  
2 means for transmitting audible signals and the means for  
3 converting sound waves into an electric current is a single-chip  
4 radio disposed on the second substrate.

1 15. The liquid crystal display of claim 13, wherein the  
2 single-chip radio is coupled to a radio frequency filter and to  
3 a tank circuit.

1 16. A liquid crystal display assembly, comprising:

2 a first substrate having an optically transmissive  
3 character;

4 a second substrate having a reflective character, the  
5 second substrate positioned adjacent to the first substrate and  
6 having a plurality of active areas wherein each of the plurality  
7 of active areas are bordered by a perimeter seal area;

8 a plurality of spacers configured about each perimeter seal  
9 area of the second substrate, wherein the first substrate is  
10 separated from the second substrate by the plurality of spacers  
11 so as to form a plurality of gaps; and

12 a liquid crystal material positioned between the first  
13 substrate and the second substrate within each gap.

1 17. The liquid crystal display assembly of claim 16, the  
2 second substrate having a perimeter, the first substrate having  
3 a glass cover, the glass cover having a perimeter that  
4 substantially follows the perimeter of the second substrate.

1 18. The liquid crystal display assembly of claim 17  
2 wherein the perimeter of the glass cover is circular and falls  
3 within an eight inch diameter.

1        19. The liquid crystal display assembly of claim 18  
2 wherein the perimeter of the glass cover comprises at least one  
3 straight portion.

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C21 20. A method of making a liquid crystal display,  
comprising:

3        providing first substrate having an optically transmissive  
4 character;

5        providing a second substrate having a reflective character  
6 and an active area bordered by a perimeter seal area;

7        configuring a plurality of spacers about the perimeter seal  
8 area of the second substrate;

9        positioning the second substrate adjacent to the first  
10 substrate so that the second substrate is separated from the  
11 first substrate by the plurality of spacers so as to form a cell  
12 gap; and

13        positioning a liquid crystal material in the cell gap  
14 between the first substrate and the second substrate.

1        21. The method of claim 20 further comprising:  
2        providing means for communicating directly between the  
3 first substrate and the second substrate.

1        22. The method of claim 21 wherein the means for  
2 communicating is at least one cross-over.

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1 23. The method of claim 22 further comprising:  
2 disposing a first alignment layer on a bottom surface of  
3 the first substrate;  
4 disposing a second alignment layer on a top surface of the  
5 second substrate, wherein the top surface of the second  
6 substrate is complementary to the bottom surface of the first  
7 substrate; and  
8 piercing the at least one cross-over through the first  
9 alignment layer and the second alignment layer.

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3 providing a mechanical press including a first plate and a  
4 second plate, the second plate having an inflatable bladder;

5 aligning the first substrate and the second substrate in  
6 the mechanical press between the first plate and the bladder of  
7 the second plate;

8 placing a shim plate between the bladder and one of the  
9 first substrate and the second substrate; and

10 inflating the bladder.

1 28. The method of claim 27, wherein the shim plate is  
2 placed between the bladder and the second substrate.

3 29. The method of claim 27, the first substrate having a  
4 first area and the second substrate having a second area smaller  
5 than the first area, wherein positioning the second substrate  
6 adjacent to the first substrate further comprises:

7 placing a shim between the first substrate and the shim  
8 plate.

1 30. The method of claim 27, wherein providing a mechanical  
2 press including a first plate and a second plate further  
3 comprises:

4 heating at least one of the first plate and the second  
5 plate.

1 31. The method of claim 27, prior to placing a shim plate  
2 between the bladder and one of the first substrate and the  
3 second substrate, further comprising:

4 obtaining a shim plate made of a flexible material.

1 (32). The method of claim 20 wherein positioning the second  
2 substrate adjacent to the first substrate comprises:

3 providing a bag having an opening;

4 aligning the first substrate and the second substrate in  
5 the bag;

6 drawing a vacuum in the bag; and

7 curing the first substrate and the second substrate.

8 33. The method of claim 32 wherein drawing a vacuum in the  
bag comprises:

back filling the bag with a gas; and

evacuating the gas by drawing a vacuum in the bag.

1 34. A method of making a liquid crystal display,  
2 comprising:

3 providing a first substrate having an optically  
4 transmissive character;

5 providing a second substrate having a reflective character  
6 and an active area including a circuit panel and a perimeter  
7 seal area surrounding the active area;

8 providing a bag having an opening;



9 aligning the first substrate and the second substrate in  
10 the bag;

11 drawing a vacuum in the bag to position the second  
12 substrate adjacent to the first substrate, the second substrate  
13 separated from the first substrate to form a cell gap; and  
14 curing the first substrate and the second substrate.

1 35. The method of claim 34, prior to providing a bag  
2 having an opening, further comprising:

3 providing a plurality of spacers configured about the  
4 perimeter seal area of the second substrate to form the cell  
5 gap.

6 36. The method of claim 35, further comprising:

7 restricting the plurality of spacers to the perimeter seal  
8 area of the second substrate.

9 37. The method of claim 35, prior to providing a plurality  
10 of spacers configured about the perimeter seal area of the  
11 second substrate, further comprising:

12 coating the plurality of spacers with a sealing material.

1 38. A method of making a liquid crystal display,  
2 comprising:

3 providing a wafer having a plurality of circuit devices,  
4 each circuit device including a circuit area and a perimeter  
5 seal area surrounding the circuit area;

6 providing an optically transmissive substrate;  
7 coupling the wafer adjacent to the optically transmissive  
8 substrate to form a cell gap;  
9 positioning a liquid crystal material in the cell gap  
10 between the wafer and the optically transmissive substrate; and  
11 dividing the wafer into a plurality of display, each  
12 display including one of the plurality of circuit devices.

1 39. The method of claim 38, each circuit device including  
2 a perimeter seal area surrounding the circuit area, further  
3 comprising:  
4

5 providing a plurality of spacers configured about the  
6 perimeter seal area of each circuit device to form the cell gap.  
7

1 40. The method of claim 39, prior to providing a plurality  
2 of spacers, further comprising:  
3

4 coating the plurality of spacers with a bonding material.  
5

1 41. A method of making a display, comprising:  
2

3 providing a first substrate having a plurality of circuit  
4 devices, each circuit device including a circuit area, each  
5 circuit device separated from each other circuit device by a  
6 scribe area;  
7

8 providing an optically transmissive second substrate having  
9 a first surface and a second surface;

8 coupling the first substrate adjacent to the first surface  
9 of the second substrate to form a cell gap;  
10 depositing an optical film over a portion of at least one  
11 of the first substrate and the second surface of the second  
12 substrate; and  
13 dividing the first substrate in the scribe areas and the  
14 second substrate in at least one direction with an aligned  
15 relation to the scribe areas to create individual display.

1 42. The method of claim 41 wherein dividing the first  
2 substrate and the second substrate further comprises:

3 cutting the first substrate in the scribe areas to cut  
4 through a portion of the first substrate;

5 scribing the second substrate in a first direction of areas  
6 of the second surface with an aligned relation to scribe areas  
7 of the first substrate and in a second direction of areas of the  
8 second surface without an aligned relation to scribe areas of  
9 the first substrate; and

10 venting the second substrate.

1 43. The method of claim 41, a first surface of the first  
2 substrate having the plurality of circuit devices, further  
3 comprising:

4 cutting through a portion of a second surface of the first  
5 substrate in an aligned relation to the scribe areas.

1 44. The method of claim 43, the second substrate having a  
2 surface area larger than a surface area of the first substrate  
3 and prior to the step of cutting through a portion of the second  
4 surface of the first substrate, further comprising:

5 providing at least one alignment mark on the second surface  
6 of the second substrate to align the second substrate to the  
7 scribe areas on the first surface of the first substrate.

1 45. The method of claim 42, wherein the optically  
2 transmissive substrate is scribed by a laser process.

3 46. The method of claim 41, the step of dividing the  
4 second substrate further comprising:

5 removing the optical film from areas of the second surface  
6 in an aligned relation to the scribe areas adjacent each circuit  
7 device.

1 47. A method of making a display, comprising:

2 providing a first substrate having a plurality of circuit  
3 devices, each circuit device including a circuit area, each  
4 circuit device separated from each other circuit device by a  
5 scribe area;

6 providing an optically transmissive second substrate having  
7 a first surface and a second surface;

8 coupling the first substrate adjacent to the first surface  
9 of the second substrate and separated from the first surface of  
10 the second substrate to form a cell gap;

11 scribing an alignment mark in the area of the second  
12 surface without an aligned relation to the first substrate;

13 dicing the first substrate in the scribe areas to cut  
14 through a portion of the first substrate;

15 scribing the optically transmissive substrate in areas of  
16 the second surface in an aligned relation to scribe areas of the  
17 first substrate to form shallow cuts; and

18 venting the optically transmissive substrate.

48. The method of claim 47, further comprising:  
19 positioning a liquid crystal material in the cell gap  
20 between the first substrate and the second substrate.

49. The method of claim 48, wherein positioning a liquid  
21 crystal material in the cell gap between the first substrate and  
22 the second substrate follows coupling the first substrate  
23 adjacent to the first surface of the second substrate.

50. The method of claim 47, after coupling the first  
24 substrate adjacent to the first surface of the second substrate,  
25 further comprising:

26 depositing an optical film over a portion of the second  
27 surface of the second substrate.

1        51. A method of making a display, comprising:  
2        providing a first substrate having a perimeter and a  
3        plurality of circuit devices, each circuit device including a  
4        circuit area, each circuit device separated from each other  
5        circuit device by a scribe area;  
6        providing an optically transmissive second substrate having  
7        a first surface and a second surface and having a perimeter that  
8        substantially follows the perimeter of the first substrate;  
9        coupling the first substrate adjacent to the first surface  
10       of the second substrate to form a cell gap;  
11       depositing an optical film over a portion of at least one  
12       of the first substrate and the second surface of the second  
13       substrate;  
14       removing material from the optically transmissive second  
15       substrate in an X-direction to reveal a top exposed substrate  
16       and an X-surface substrate;  
17       removing material from the optically transmissive second  
18       substrate in a Y-direction to reveal a side exposed substrate  
19       and a Y-surface substrate  
20       removing material at the top exposed wafer in a direction  
21       that is parallel to the X-surface substrate to form an X-  
22       registration;  
23       removing material at the side exposed wafer in a direction  
24       parallel to the Y-surface substrate to form a Y-registration;

25 drawing cuts into the first substrate using the relative  
26 registration provided by the X-registration and the Y-  
27 registration;  
28 scribing the second substrate; and  
29 venting the second substrate.

1 52. A method of placing liquid crystal material within an  
2 individual liquid crystal display device, comprising:  
3 providing a chamber having a dropper containing liquid  
4 crystal material;  
5 providing an individual liquid crystal display device  
6 having a perimeter seal area that defines a gap and a fill port  
7 that serves as an entrance to the gap;  
8 arranging the display device within the chamber so that the  
9 gap faces the dropper;  
10 drawing a vacuum in the chamber;  
11 dispensing a drop of liquid crystal material from the  
12 dropper onto the gap;  
13 introducing pressure into the chamber so that the liquid  
14 crystal drop is drawn into the gap.